TRANSIT of VENUS—The MOON

FOURTH LECTURE OF PROF. PROCTOR AT ASSOCIATION HALL.

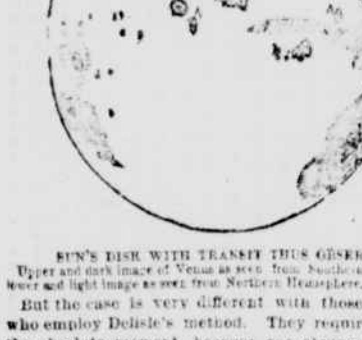
HOW THE TRANSITS OF VENUS ARE OBSERVED—THE IMPORTANCE OF THE TRANSIT OF 1874—THE MOON'S ASPECT AND MOTIONS—HER SERVICES TO THE EARTH—LAPLACE'S IDEAL MOON—LUNAR PHOTOGRAPHY—THE MOON DESTITUTE OF WATER AND AIR—THE MOON'S PROBABLE HISTORY, SHAPE, PRESENT CONDITION, AND APPARENT VOLCANIC PHENOMENA.

Prof. Richard A. Proctor delivered the fourth of his series of lectures on Astronomy at Association Hall last evening, the subject treated being "The Transits of Venus and the Moon." Ingenious diagrams were employed to depict the various appearances of the moon as observed through the telescope, and delineate the path and points of view for the coming transit of Venus, which occurs this year, and which is at present a topic of greatest discussion and interest to astronomers. The audience was very large, and the lecture was listened to throughout with the closest attention.

THE LECTURE.

It has seemed well to the gentlemen who have arranged this course that a few remarks should be made upon a subject at present attracting great interest among astronomers—I mean the question of the approaching transit of the planet Venus. You know, of course, that on this transit depend the best methods of determining the distance of the sun, and that upon determining the sun's distance depends our estimate of all the dimensions of the planetary system. Therefore that is the fundamental problem of astronomy, because when we pass on to the stars also, our ideas depend on that one fundamental measurement of distance. Now it happens that the planet Venus, by coming between the earth and the sun, enables us to measure that distance in a manner very easily explained. We know that the distance from Venus to the sun is to the distance of the earth from the sun as five to seven. If observers at the north and at the south of the earth's globe look at Venus at a time when she is directly towards the sun, the southern observer will see Venus at the highest of those stations, and the northern observer will see her at the lowest of those stations; say they are 6,000 miles apart; then we know the distance apart of the lines that Venus appears to have traveled on the surface of the sun is 15,000 miles, and then we know the whole diameter of the sun is so and so, because we can compare it and know it is proportionately so much larger. We ascertain the diameter of the sun, and if we know the size of any object and know how large it looks, we know how far away it is. You see that having this distance of 6,000 miles we ascertain that distance of 15,000, and afterwards, knowing the diameter, we know the distance of the sun. But then it is not possible for observers to note the planets at two points like that, because they are not in communication. Those two observers at distant places cannot work at the same moment. The southern observer watches Venus crossing the sun's face on the northern track, the northern observer sees her on the lower track, and if they note how long a time she takes, they determine how long those two tracks are, and then it is a simple problem in geometry to tell the distance of one from the other. That is Halley's method. Again, you will notice that the observer who sees Venus traveling this longer course will see the transit begin earlier than the observer who notices her traveling the shorter course. Therefore, if one observer is placed where Venus begins as early as possible, and another is placed on the earth where Venus begins as late as possible, by comparing those two moments it becomes a mere geometrical problem to tell where those chords are and how far apart they are. This is Delisle's method. Halley's method requires only two observations of the length of time Venus takes. If they have a very ordinary kind of clock, so long as it does not gain or lose during the time their observations are in progress, their result is achieved.

DELISLE'S METHOD OF OBSERVING THE TRANSIT.
A, B, stations on opposite sides of the earth. A a part of the earth's orbit. V, Venus. C D and E F apparent paths of Venus on the sun.



SUN'S DISK WITH TRANSIT THUS OBSERVED.
Upper and dark image of Venus as seen from Southern Hemisphere; lower and light image as seen from Northern Hemisphere.

But the case is very different with those observers, who employ Delisle's method. They require to know the absolute moment, because one observer is as far away as possible on the opposite side of the earth from the other. They cannot communicate, and, therefore, the only way they can compare their time is by knowing the true time at their station. But in order to know the true time it is necessary that the longitude should be known. Suppose in England a certain event happened at 5 o'clock in the afternoon; then you will know it in New-York as earlier by five hours. It would certainly be difficult to be accurate within a second or two. Now, in order to apply Delisle's method the two observers must know the true time of their stations within a second or two, and while this obstacle might be surmounted in such places as Greenwich, Washington, Paris, &c., yet it would be very difficult to do it in a desolate place or island on the earth's surface; and that is the difficulty of Delisle's method. [It is very well worth noting that during seasons of observations made between Greenwich, Paris, and Washington, the Washington observers, by making a comparison between those results, found the true difference of longitude between Greenwich and Paris. American astronomers were the first to give the true difference of longitude between Paris and Greenwich.] You will notice what we have to do in these two methods are two very different things. Halley's is easy, and the other is difficult.

Then comes the history of those matters by which the observations of the next two transits have been determined. By an unfortunate mistake in 1857, repeated later in 1868, the Astronomer Royal of England came to the conclusion that Halley's method could not be applied to the year 1874, and he came also to the conclusion that it could be applied to the transit of 1882. Therefore, observations were to be made by that method in 1882, and expeditions would have been prepared for that purpose, when I chanced, in looking over the arguments of the Astronomer Royal, to discover that he had arrived at a conclusion that was erroneous. I found those statements must be reversed; that it is in the transit of 1882 that the latter method must be applied, while this year Halley's method can be employed with great certainty. I made the statements accordingly. These pictures indicate the point on which my reasoning was based. Here is the earth as seen from the sun at the moment the transit begins. Therefore at any place now in view the beginning of the transit must be seen. Here is a picture showing the earth when the end of the transit of 1874 can be seen. Now, you notice the beginning occurring here in North Asia, Japan, &c.; the end can also be seen in those regions. So that the beginning and end are thus seen. There is nothing to be done but to place observers in those parts of the earth and they, seeing the beginning and the end, will know the time it takes. Southern stations also exist, as you see, for seeing the whole transit. Therefore, there is nothing to prevent northern and southern observers from making those observations necessary to Halley's method. The northern observer will notice Venus at the lowest of those lines, while the southern watcher will see the uppermost or shortest of those lines. Everything they want is ready for them, and all that is necessary is, that another observer should be sent to this part of the earth, to this more desolate region [pointing it out on the diagram], and then the whole thing can be accomplished.

In the transit of 1882 there is a different state of things. Here is the surface of the earth at the beginning of the transit in 1882. Here is North America. New-York and Washington are there, and the beginning and end of the transit can be seen from that northern region; but there is no southern place where the whole of the transit can be well seen. There is a great change between these former features and those we have now. The transit will only last four hours in 1874. The chord of the transit is very short. In 1882 you will notice South America is carried right away the other side of the earth, and the result is there will be a very great change in all the stations. You will notice the only southern station where the beginning and end of the transit is ever seen is in Possession Island, and another here at Repulse Bay. But although they are in view there, they are so close to the edge of the disk at the beginning of the transit that at that moment the sun, I found, would only be four degrees above the horizon. It becomes a difficult problem, a very difficult observation, to tell within a second or two when Venus touches the inside of the sun's edge, and that observation cannot be made when the sun is so low down.

MR. PROCTOR'S EFFORTS TO OBTAIN A HEARING.

Then you see the condition of the two transits. You may know that America has done more than her share in that matter. There are as many as seven stations to be occupied by North American observers in these northern regions, and then, beside, they are sending observers to this southern region. In this controversy, I must admit I spared no efforts. At the beginning of last year, when I found the time was drawing near, I used all means to get my views urged as strongly as possible. The whole controversy has been about this point: whether England will change the arrangements originally made to select and search out the place in which to see the transit from the Southern regions. I spared no efforts—writing in daily, weekly, monthly, quarterly papers, for which I was abused right and left—to insist upon the true views of the matter. It is objectionable always to insist upon views, unless there is good reason and the time is near when a decision must be taken. Feeling that no time was to be lost, I for the moment neglected that rule, in order to press my arguments; and last June, at a meeting at the Greenwich Observatory headed by Prof. Adams, the greatest of astronomical mathematicians, it was proposed that measures should be taken to search over the sub-Antarctic regions, and the proposition was unanimously carried by all the astronomers present. That has already been done, and I hope good results will be obtained. One other point I noticed in making my examination. By another great mistake of the Astronomer Royal—who, it should be remembered, has other duties to perform at Greenwich, which take up all his time—this particular region on the chart here in India, where the beginning and end of the transit will be seen, was overlooked. It happened that the name of the map fell exactly on that region and obscured it, so that the mistake arose. I recognized that region, and after a shorter struggle of about two years that region has been selected for a new station, so that the transit will also be observed from that point.

If I mention this, it is because some reason must be given in excuse for the opposition of a comparative beginner against one not merely standing high, but deservedly standing high, as does the Astronomer Royal. No man living has done so much for the cause of astronomy, given so many years of his life to the work, and has labored so energetically in it, as the Astronomer Royal. But the time was approaching when it would be too late to speak, and many years must pass before a similar occasion would return. This induced me to come forward, and nothing would have led me otherwise to take so energetic a part as I have done in this matter. Now I leave this matter of the transits of Venus to pass to the study of the moon.

THE MOON AS A GIVER OF LIGHT.

When I dealt with the subject of the sun, I spoke of the worshipers of the Sun, who knelt down to him and regarded him as the ruler of their destinies, but there were nations who worshiped the moon, and if we inquire into the reason of such worship we very readily find it. We notice that Job speaks of the moon as *walking* in brightness, and he speaks, too, of the subject of the moon's worship. It was natural that men should worship the moon. The ancients worshiped any body that seemed to move upon the heavens, and, therefore, they worshiped the sun, the moon, and the planets.

Now this orb that moves around the earth seems to be there in order to give light during the night time. Let us see what astronomy has taught us. It teaches that the moon is very much smaller than the earth, with a diameter of 2,100 miles. She is distant from the earth 238,828 miles. The surface of the moon is less than the earth's in the proportion of 1 to 13½. In other words, the surface of the moon is about 14,600,000 square miles, equal almost exactly to the surface of North and South America. It is also equal approximately to the surface of Europe and Africa taken together. If the moon is the abode of life there is plenty of room for life there, and it is an interesting question whether she now can maintain life. We know that the volume of the moon is to that of the earth as 1 to 49¼, while her density is rather less than that of the earth, so that her mass is to the earth as about 1 to 81.

First of all, as to the offices of the moon. If it is shown that she discharges important offices to the earth, you will see that we are no longer bound by the argument of design to recognize her as the abode of life. First, we know she serves for the division of time. She gives light by night. God set His lights in the expanse of heaven, the greater to rule by day and the lesser by night alternately. There is a service performed by the moon which is so regular as to suggest that perhaps the Almighty intended the moon for that special purpose.

Laplace went so far as to say if he had made the moon he would have made it much more useful to man. He would have put it four times its present distance away from the earth, when it would be far enough away to be a full moon and give a regular light continuously by night. The first objection to this is an astronomical one, for of all nuisances the moon's light is one which the astronomer dislikes most, especially at a time when he wants to study some nebulæ, or some barely visible comet; at those times the moon's brightness seriously interferes with his observations; and I am surprised, indeed, that Laplace, himself an astronomer should have suggested so inconvenient an arrangement as that. But there are other difficulties. If the moon is in that condition she would always have to be opposite to the sun. The sun would go around once a year and the moon also. The moon would no longer be a measure of time, she would no longer rule the tides in the same way. She now raises a great wave called the tide-wave, represented in hight by 5. You have another caused by the sun, represented by 2. Those two waves are sometimes combined in a single wave, and act together, sometimes opposing, sometimes coalescing. According to these changes, the tide varies in hight from the difference of 5 and 2 to the sum of 5 and 2. That is to say, 3 the least hight and 7 the greatest. That is a very important matter. It is of great service, as any one who lives by the seashore knows; it is of great interest to the shipbuilder and merchant that there should be variable tides, that there should not always be high tides, nor always low. That important service would not have been subserved by the moon if the consideration suggested by Laplace had prevailed. There is another very important service. The moon enables the astronomer or seaman in long voyages to ascertain the longitude, which is nothing more or less than the true time at the observer's station. If she moved 12 times more slowly she would be less fit to indicate the time in exactly the same degree as the hour hand of a watch is less fit than the minute hand. There are other very great and important advantages of the real moon over that suggested by Laplace, which I wonder did not occur to a mathematician such as he, the only man who ever lived of whom it can be said "He was the rival of Newton." He himself said Newton was fortunate in having lived before him. In another man it would have been rank conceit, but in Laplace it was considered as a just statement. Yet he failed to notice, when he suggested this moon's being four times further from us, that under his conditions if spread so as to give the same light, the material of which the moon would be made would be lighter than any solid element known to us. I think it was well that the Almighty did not take counsel from Laplace in creating the moon.

TELESCOPE VIEWS—THE MOON HOAX.

I pass from these considerations to the telescopic study of the moon. When we think how near the moon is, the planet that comes nearest to us being 150 times further away than the moon, certainly the hope would seem natural when Galileo first turned his telescope to the moon that he would discover signs of its fitness to be the abode of life. We know what happened. He found there a surface covered with mountains so that he compared them in number on the moon to the "eyes" on a peacock's tail. Where there appeared to be dark surfaces of a level nature he called them seas. He found them to be really solid, and afterward telescopic observations went on, and all that was found was the gradual enlargement of these features, and the revelation of new details, but nothing to suggest that life existed on that arid surface. Men went on hoping that with telescopes of increased size more would be obtained. It was thought that with Herschel's great telescope something more would be determined. Herschel thought he could recognize in the bright part of the moon signs of volcanic action, because he saw a faint light as of volcanic eruption. We know it was only the reflected light of the earth.

Other efforts were made, and it was at that time that some one in America, a Mr. Locke, conceived the idea of publishing that strange book, the Moon Hoax, which misled not only the mass, but those who were well educated. There was great ingenuity displayed in the method of its construction. There is the conversation between Brewster and Sir John Herschel, the enthusiasm of Brewster, which is very comically described, as he leaps from his seat and, catching Herschel by the hand, exclaims, "Thou art the man!"

Then a curious appearance of different flames, and then animals which seemed to escape away whenever the observer tried to fix his attention upon them; and the Bat-men—monstrous creatures—and the comparison between these Bat-men and the militia of London. At this point the story seemed too absurd for belief; yet we can imagine the impression it made, when some one wrote to Sir John Herschel from America, asking if it was true, and urging means of conveying religious instruction to the poor benighted inhabitants of the moon. [Laughter.] And, strangely, at a quite recent time, the idea has been suggested of studying the moon, so as to discover living creatures there, by the same method. I saw a few days ago in an American paper an idea based on the same mistake that existed in that Moon Hoax, only there it was not a mistake but a trick. If you have the image of the moon photographed to perfection, it seemed as though you might magnify that image by the microscope and see objects of half a mile or less in size, if not recognize living creatures. But this is the same mistake as those make who believe in the transfusion of light. What the astronomer does when he sees the moon through a telescope, or when he takes a photograph of the moon is to magnify the image as much as it will bear. If he interposes a screen and tries to magnify the image, he is magnifying a moon less perfect; his best chance is by looking through the eye-piece at the image in the focus of the telescope. There is a limit in the telescope beyond which it cannot be increased. I heard, a few days ago, that the observatory to be established on the Rocky Mountains will bring the moon within thirty miles of us; but that is impossible. It is not a question of a place above the atmosphere, seeing the moon through the rarer parts of the atmosphere, but the optical difficulty. The optical image formed by the object-glass of the astronomer has defects, and if you magnify it you magnify the defects. When you get beyond a certain point it is useless to magnify the image as it appears, and there is no hope of any telescope larger than Rosse's to get a close view of the moon. [The best view of it obtained, perhaps, is that at the Cambridge Observatory.] We have images here taken by the Cambridge refractor, and there are all the details, as you see, of the craters and flaws and irregularities of surface, but no sign of life can be seen.

EVIDENCES OF ABSENCE OF ATMOSPHERE.

When we begin to inquire into the relations of the moon, we see how hopeless it is to expect signs of life. We have an orb having no atmosphere, or a very shallow one. This is shown by the fact that shadows thrown by the lunar mountains are seen as these black parts, indicating that there is no considerable atmosphere. An observer watching our earth from the moon would not see black shadows but dark shadows, of greater and greater darkness, but there would be a certain amount of light in the valleys all around the mountains; for we know we can stand on a mountain top when the sun is rising and see that the valley below is not black; there is twilight there, and it comes from the atmosphere. If there were atmosphere in the moon an observer from the earth would see shadows thrown all around the mountains, but not black ones. The blackness of the lunar shadows shows that there is no illuminated sky such as ours, no atmosphere to illuminate those regions, and that is the first proof that the moon has no appreciable atmosphere.

On our earth, as you know, there is a twilight surface extending a very great distance, which divides true sunlight from the place where there is no sun, and the twilight surface extends over 18 degrees on the earth. On the moon we can recognize no twilight surface whatever. Look at the earth from the moon, the picture of the "new" earth, when the earth is between the sun and the moon, and there would be seen all around the black disk of the earth this twilight. We, as you know, on the contrary, when we have a full moon, see the edges sharply defined; it is only the same circle, no extension on either side by twilight surface. That is the second proof of it. Yet another proof of it. When the moon passes over a star, the star flashes out suddenly; if there were an atmosphere round the moon, that star would be seen precisely as our sun when sinking. When he sinks, though he seems not to pass below the horizon, yet he is really below it, and a line drawn from the sun to the earth would pass below the horizon. There can be no doubt that if you are looking at the earth from the moon, you would see the stars close around the earth, when they were really behind it, they would be raised by refraction of the earth's atmosphere. Now, in the moon's case, we see nothing of that kind. A star, even some telescopic star, is visible in one moment on the moon's edge, and the next it is gone. These are three convincing proofs that the moon has no appreciable atmosphere, and if it has no atmosphere, there can be no life such as we know. There may be life of other forms inconceivable, and it would be idle to inquire what they may be. I believe there is no life. I find a limit to where life is on our earth. We may say the conditions on our earth are not the same throughout—greater or less light, less moisture or more moisture; but we find that these conditions really limit life on the earth; beyond a certain hight on the mountains there is no life except of mere animalculæ and these carried up by the air; and so far as analogy teaches us we must believe that there is no life in the moon.

THEORIES TO ACCOUNT FOR THE CRATERS.

Besides, there is no sign of water. We can recognize regions, such as those inclosing the floors, which are sometimes perfectly level, and sometimes show streaks and marks, and they always remain unchanged. If there were water, the water under that shallow air would be raised into the lunar atmosphere, and increase or decrease these markings.

Now, it certainly seems probable at first sight, while the aspect of the moon is such as I have described, that at one time or other there must have been a great amount of vapor around it. All the craters must have thrown out enormous quantities of vapor. There are those who say, as Prof. Mallett of England, that there are no volcanoes without the action of water. If that be the case, these signs of past volcanic action in the moon are due to volcanic eruptions, and there must have been water on the surface. What has become of the water? There are four suggestions made in reply. One, that a comet carried away the lunar oceans and atmosphere. We give up that at once. It was the theory of Whiston, who accused Newton of being jealous of him, and Whiston's name has been nearly forgotten. He thought that a comet would cause the destruction of the earth by fire, and that one had already done so by water. But we know that while the moon might get something from a comet, no comet could draw anything from the moon.

Another one I was once attached to is that the surface is covered with frozen snow. I was one of those who held this theory, and as it is exploded I will take it for my own. Say the white surface is covered with snow. That whiteness must be accounted for, and there are signs of a great downfall of snow and glaciers, and the atmosphere also may have become frozen. Carbonic acid gas may be frozen into something like snow. The objection to that theory is that the moon is not white; it is more nearly black than white. I dare say you remember Dr. Tyndall's telling you that if the moon was black, it would yet be white in the sky. Measures of its light have been taken, and it appears that it is no whiter than weather-beaten brown sandstone. Sir John Herschel discovered it thus. He noticed the moon setting by a mountain of sandstone, and their respective reflections of light were the same. Certain parts of the moon are brighter than others, and from Zollner's observations it seems that these may be looked on as white, but great portions of the lunar regions are probably darker very much than our ordinary skies.

Another explanation is that the lunar oceans have been withdrawn into the substance of the moon. Mars has oceans smaller than ours, when the earth is compared with his dimensions; and we may suppose it due to the withdrawal of a portion of the water into the planet. The planet in cooling contracted and left spaces into which a portion of the water withdrew. We should find reason for believing that Mars, a small planet, in cooling, cooled so much that all the water would be withdrawn into the interior. But there is a difficulty in that; the atmosphere remains unaccounted for, and it seems difficult to understand that any atmosphere of moderate extent would be withdrawn entirely within the lunar cavities and give no sign of existence.

There remains yet another theory—that the moon is egg-shaped, and the center of gravity being displaced on the further side, has carried to that side the oceans and air of the moon, and that the side of the moon never toward us may be a comfortable abode of life. The little of the egg toward us has no waters, and they are drawn to the further side. The one objection to that is, that if the moon is egg-shaped, the oceans and the atmosphere ought to be on this side instead of the other. If the more pointed end of the egg-shape were toward the earth, it would correspond to a hill of matter, to a pile of it on our side. That pile of matter would act as an attracting cause and draw the oceans and the atmosphere from the further side to this side; and we find, so far as I can see, no theory accounting for the displacing of any former oceans or atmosphere in the moon. We have great difficulties to account for, and we may find reason to doubt whether the signs of volcanic action indicate eruptions, or whether they may have been produced by forces acting from outside.

PHOTOGRAPHIC PICTURES OF THE MOON.

We will now have the room darkened, and pass to the examination of this picture. This picture of the moon in the first quarter is not that which you see with the naked eye. You see it left for right, because in the telescope one always sees it this way, and it is preferable to follow the plan in the books on astronomy and show the pictures as shown by the ordinary telescope. We will now have the second and third quarters. The photographic study of the moon was commenced by your American countryman, Dr. W. H. Draper, in 1840, and one of the works we study is so much in advance even of those men of the present day that we owe a great deal to Dr. Draper. He began in 1840 his photographic work on the moon, and that work greatly increased in perfection. Mr. De La Rue of England got a mastery of photography, and Mr. Rutherford of New-York made maps which Mr. De La Rue acknowledged frankly were better than any one of his, owing to the clear atmosphere of New-York. Dr. Henry Draper made lunar photographs earlier. I have had no opportunity of comparing his with Mr. Rutherford's, and I should be sorry for you to suppose that in the superiority attributed to Rutherford's photographs I was making a comparison between Mr. Rutherford and Dr. Draper.

There you have a picture of the full moon, and you will notice how exceedingly dark these ridges are on the bright upper region of the moon, and that wonderful region which is called Tycho, and that wonderfully bright region where crater overlaps crater, even as it is there shown by the photograph and more remarkably by a telescope of great power. Dr. Schmidt of Athens has been counting the number of these craters, and that number has gone on growing greater, until at last a map of so many has been made that they cannot be distinguished one from another. This work of Dr. Schmidt's was the noblest work of that kind that exists, and it is very unfortunate that we cannot get money enough in Europe to publish it, and make him some remuneration for the work of so many years. We will now have a map of the gibbous moon, passing on to the third quarter. This picture is by Mr. Rutherford. Around the right of the moon we begin to see a region about which a very important discussion has lately taken place. Low down on the right is a small dark round spot, on this curved bright streak. In the middle of that is this dark round spot, called the Floor of Plato. It looks very dark indeed, especially in the case of the gibbous moon. In the next picture you will see how it becomes apparently lighter. When this is looked at closely, and certainly when looked at through a telescope, it is found that it looks lighter at the time of the quarters than at the time of the full moon when brightly illuminated. Now, it has been suggested that on that spot some process of vegetation is taking place. In that case we should have a very striking fact of some change taking place there. Unfortunately for that, it happens that there is also a strong argument against the theory that there has been any real change there. Of course when you view the spot at the time of the quarters you have shadows thrown and in contrast with those shadows, the floor of that spot naturally looks lighter. Whereas in the case of the full moon, all around it there is a brightly illuminated region. The mountains have a great illuminating power, and therefore by contrast the spot looks dark. I have made the calculations myself, and found that that is absolutely the case; instead of growing dark with the full moon, it grows lighter. It is a mere subjective effect, and we have not the evidence we hoped for, evidence of change. There is an illustration of that fact in the appearance of the satellites of Jupiter in their transit across the face of that planet. They look black by contrast, but start into brightness as soon as they move off the disk of the planet.

THE LUNAR MOUNTAINS.

We will have this other picture, which Delapue said was better than any he ever took himself. We have here the moon in the third quarter. Here is the lower region, the Floor of Plato, here the lunar Apennines, here the crater of Copernicus, and here the lunar crater Aristarchus, the very region where Sir John Herschel noticed a bright spot which he took for an eruption. The fact was that that very bright spot, by reflection of the earth's light, became visible. That was the truth of it. We will now have a picture of the very same thing, only more distinctly shown; the details are somewhat more distinctly shown. The Apennines can be very plainly recognized, passing in a curved streak upward. Here is Copernicus, here Kepler, and here Aristarchus. From these three centers there is a radiation, and it appears clearly to observers that the strata were upheaved at different times; the later ones seem to break through the earlier ones. It is hoped that by that characteristic we can learn something of the chronological order in which the changes of the moon's surface took place.

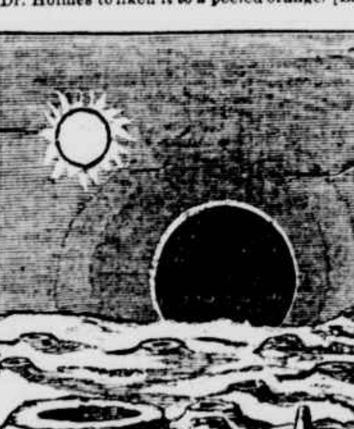
This picture has been enlarged by Mr. Rutherford. Here is Copernicus and here you see the Apennines on the lower lightened side. The moon you see is covered all over with these irregularities. We know how volcanic eruptions are brought about. First there is a gradual contraction of the skin, the outer crust of the earth; a mechanical effect is produced gases are generated, and these gases escape out of the mouth of the volcano. If any such processes had happened upon the moon it would have been much more violent. But then one would have thought that any one of these lunar craters, the largest being two or three or four miles across, would have been large enough to let all the gas in the whole moon escape. Now, what was the necessity of so many? It was suggested by Dr. Hook that in a former state of existence, there was a bubbling, and as the bubbles broke these circular openings were formed. We will have another picture brought on, still further illustrating this. Here you will see the Floor of Plato again, and the Apennines also, seen running across toward the left of the picture. This crater is the crater Aristarchus.

We will now have that carried away, and have another series of pictures of a different kind. We will have two pictures of the Floor of Plato. You will notice that the shadows there are thrown on the floor, in the picture on the right. In the picture on the left, where it is morning, you will notice how that long bank differs from the appearance as presented on the right. You recognize how far the appearance of the moon may change, from a mere change in the illumination, and how difficult it is to say that changes are going on, from noticing the apparent changes. Here is an illustration. It appeared that a certain crater had vanished, as though a sort of cloudy matter had been thrown out. When the supposed volcanic eruption ceased, the hills apparently had been made more sloping, and the crater could not be so well seen. But unfortunately for this supposed evidence of change, the crater has again appeared as before. Our moon changes and shifts, not merely with regard to the sun, but to the earth, and, by a calculation of mine, I find that 1,300 years must elapse before you could see any part of it again in the same view exactly.

You have now a picture of the lunar crater Copernicus. This picture is very different from that taken by other observers. It is quite manifest that the skill of the artist has worked out the picture in a certain way, and as another will work it in another way, it is by comparing the two that you are led to think that there was a change. I must mention that the moon is unlike our earth in its general conditions, in nearly all the important respects which we associate with it. The total day lasts 29½ of our days. While the day lasts so long, the year is very much less than ours. It is only 346 of our days. It may seem rather strange that as the moon is a planet, in reality, that therefore it has a year less than ours; that it ought to be the same as ours. But there is a slow tilting of the moon, corresponding to the precession of the equinoxes. That shortens our year by a few hours, but in the moon it shortens it for a few days.

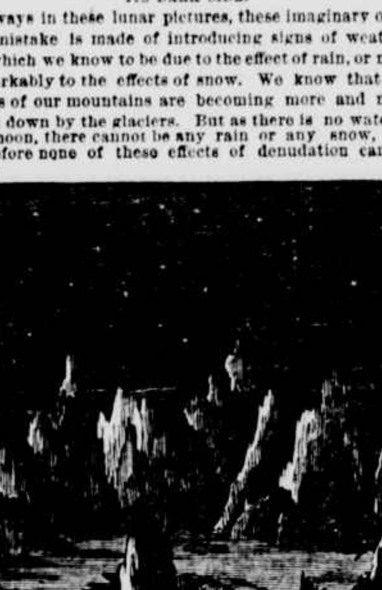
AN EARTH-LIGHT SCENE ON THE MOON'S SURFACE.

There you have a picture of the lunar crater Copernicus as it might appear to the inhabitants of the moon. It was drawn by James Hamilton of Philadelphia. You will notice the earth suspended as a moon to the inhabitants of the moon. The earth is, according to my conception, too small. It would appear to them as a moon 13½ times as large as the moon appears to us. We will have a picture of the lunar crater Tycho, from which those great radiations extend, which give the moon the appearance of an orange, and which caused Dr. Holmes to liken it to a peeled orange. [Laughter.]



SUNLIGHT SCENE ON MOON'S SURFACE: EARTH SHOWING ITS DARK SIDE.

Always in these lunar pictures, these imaginary ones, the mistake is made of introducing signs of weathering which we know to be due to the effect of rain, or more remarkably to the effects of snow. We know that the peaks of our mountains are becoming more and more worn down by the glaciers. But as there is no water in the moon, there cannot be any rain or any snow, and therefore none of these effects of denudation can be seen.



IDEAL VIEW OF MOUNTAIN SCENERY IN THE MOON.

Here is an ideal picture of the Apennines. You will notice the peculiar slope of them. Again we have the erroneous signs of weathering. You never see mountains like those except where snow is. In the picture you are supposed to be looking at the Apennines from Aristarchus. Here is a picture in which you are supposed to be looking at them from Plato. You will also see a little work of the imagination here; a little village is interposed, probably the dwellings of inhabitants of the moon who were to have received religious instruction from the earth, for you perceive there is a church there. [Laughter.]

We will have a picture brought on showing the wonderful way in which the moon is covered with craters. It is different from the appearance of craters and mountains as we picture them to ourselves. When you look at that you will begin to think that there is some other operation at work there than that which produces our mountains and the few craters we have. You seem to have an appearance produced by boiling over, or the pouring down of some very heavy rain, as a heavy rain on a muddy surface produces pits like these. As regards Dr. Hook's explanation, I need hardly say that bubbles would probably not be formed so large as that, and no forms of matter known to us would be coherent enough to form these of miles in extent. We seem forced to a theory very startling, that we had on the moon's surface a pounding down of meteoric missiles, not necessarily solid ones, but a falling down of meteors on the plastic surface. It seems to me to be the only theory left. At the present day it is estimated that over 400,000,000 meteors fall through the day, but the result is very slight indeed. I have found that the earth would require 400,000,000 years to have her diameter increased a single inch by them. When we look back upon the past history of our system, we see signs that there was a time when larger meteors and more splendid comets were at hand to be absorbed in the solar system. While the earth was still in a form of vaporous matter the moon was rolling on, still plastic, and these meteors falling down upon her surface would produce that pitted appearance.

I will have the room lightened up again while the small lantern is prepared, and then I will have three pictures of the residue from boiling a calcareous solution. You will see how very much like my pictures are those of the moon. I will undertake to say that all those who are not acquainted with every nook and cranny of the moon will be deceived by these, especially the third and last one. You will notice that there appear in them seas which have terraces around them.

I will now invite you to notice what was suggested to me by Dr. Barnard of Columbia College, that we have in the solar system the signs of a beginning and of an end. Jupiter and Saturn have made progress to a further state than the sun, but are still full of life and energy. Then in the progression comes our earth, and Mars, and Venus, and Mercury, which have lost most of their inherent heat. In the moon we have a body seeming to have lost all its inherent heat, and to have neither water nor air. All these signs of progression seem to point to the day of creation and teach us to look forward to the time when these processes began. We seem to see signs of beginning. There must have been a beginning of these processes which in the moon have come to an end. Looking forward we see that our sun, the youngest as it were, so far as signs of passing on at old age is concerned, will one day lose heat and all the other members of the solar system will have lost theirs. There seems to be an end of our solar system, a beginning and an end marked, and in that respect astronomy differs from other sciences, which give us no such signs of a beginning or end.

CALCAREOUS RESIDUE LIKE MOON PHOTOGRAPH.

In this picture of the residue of a calcareous solution before you, notice the black region around the crater and signs of terraces. You have in the next picture no terraces visible. Ninety-nine observers of the moon out of a hundred would not be able to tell me that this is not a photograph of some part of the moon's surface.

There is one point I intended to touch on more fully. I spoke of the possibility of any planet only being intended to be inhabited during a short time, of the existence of the planet. Millions of years before it was fit, being followed by millions of years after it became unfit for habitation. Let us have an illustration of that. If it were known that some gentleman in Brooklyn only intended to remain at home ten minutes on a given day, and you did not know whether it was morning, noon, or evening, and you called at random, you would be surprised to find him at home. Take any particular time in the same way, and consider the chances that the planet is inhabited in it. Why, the chances are small; much more in favor of the present moment belonging to the millions of years before or the millions of years after it becomes fit for habitation. That is the case with the moon, I feel tolerably certain.

That the moon has long since passed the time when it was fit to be the abode of life was touched upon in the second lecture, and that Jupiter and Saturn have not reached the time when they are fit. But though we are much more likely to see a planet when it is not fit for habitation, we must take the immense number of them into consideration. There are millions of stars and millions which no telescope can reveal and you have the chances reversed; and though for every planet inhabited now there may be millions not inhabited, yet the number inhabited must be many millions. So that we get rid of the painful thought that our insignificant planet is the only one inhabited. We get rid of the difficulty that the greater number we know of are not fit for habitation, and we can address the Creator in the language of the poet,

> God of the grass and of the rose,
> Soul of the sparrow and the bee;
> The mighty tide of being flows,
> Through countless channels, Lord, to thee.
> It leaps to life in grass and flowers;
> Through every grade of being runs;
> While from Creation's radiant towers,
> Its glories flame in stars and suns.

THE EARTH LOSING TIME.

To the Editor of the Tribune.

SIR: Mr. Proctor, in his lecture this evening, gave an interesting account of his determination of the time of the revolution of Mars on his axis. The lecturer showed that he had eliminated an error of all previous calculations of one-tenth of a second. This, doubtless, would be very interesting to the Martial inhabitants, but, unfortunately, we cannot advise them. A more interesting statement of the lecturer, to earthly inhabitants, at least, is the fact of the earth's losing time in its diurnal revolution. The lecturer did not say how much our great time-piece is losing time. Will he kindly give us this information in his next lecture, and enable us to make our calculations accordingly?

Brooklyn, Jan. 12, 1874. SCOTUS.

WORDS OF CHEER.

MEAT AND HONEY TO ITS READERS.

To the Editor of The Tribune.

SIR: In the days of Addison and Steele, *The Spectator* was indispensable to the reading community in London. So, at the present time, is THE TRIBUNE indispensable to its readers wherever found. From time to time various opinions have been offered respecting the merits of THE TRIBUNE. May I be permitted to give one? I have been a constant reader of this valuable paper from the first, and have invariably found it to be my meat and my honey. Not surpassed by any other periodical of its kind, it may well be regarded by an admiring world as a gigantic work, a noble structure. If I have ever worshiped any man upon earth that man was Horace Greeley, ardent toiler for the good of his fellow-men. When our dear Mr. Greeley stopped a few moments at our railroad station, on his last Eastern tour, I was the first to shake hands with him. True, on the occasion referred to the Democrats vastly predominated; but no matter for that. I could shake hands with the great Editor as cordially as you please, in view of his past herculean labors for the benefit of mankind.

It has been often remarked that, politically, THE TRIBUNE has changed very much since the time of Mr. Greeley's nomination for the Presidency. Leaving this consideration wholly out of the question, I offer the following as the result of my better judgment respecting THE TRIBUNE as we now find it. Aside from all the political sentiments put forth in its columns, THE TRIBUNE is richly worth many times the price of its subscription. The column of "Home Interests" alone in THE WEEKLY and SEMI-WEEKLY is invaluable, and is not to be compared in dollars and cents with the subscription price of THE TRIBUNE. I challenge any person in the world to name a paper which, for general intelligence, is ahead of THE NEW-YORK TRIBUNE. Please accept my best wishes in behalf of the noble efforts you are using to make it a truly valuable paper. J. H. W.

New-Gloucester, Me., Dec. 10, 1873.

FROM ONE WHO LOVED MR. GREELEY.

To the Editor of The Tribune.

SIR: I have been an almost constant reader of Horace Greeley's publications since he started *The New-Yorker*. I own and have read his "Life" by James Parton, and his own great work, "The American Conflict." I am making a scrap-book. In that can be found many of the lies of the newspapers and prominent men published and uttered during the last Presidential canvass against that great and good man, Horace Greeley. After his death come in some twenty pages in mourning, of the obituary notices of many of these same newspapers and public men, as well as of some who had not slandered him. How different the reading! A prominent trait of the American people seems to be to slander, lie, and abuse as long as there is breath in the body; as soon as that is gone then to eulogize and praise his virtues. I am no man-worshiper, but I said years ago, and I believe to-day, Horace Greeley had more influence than any other man in the United States. Now, as before stated, having been a reader of the publications of Horace Greeley for nearly 40 years, and an admirer of the man, can it be doubted that at his death my anxiety was great for the few months when there seemed to be a doubt who would be his successors, and what THE TRIBUNE would be under their control? Many a time have I been asked, "What do you think of THE TRIBUNE now?" For a time my reply has been merely of a hopeful kind. Now I am prepared to make it positive, and say I firmly believe his mantle has fallen upon worthy shoulders; men who, in the future, will make it what it has been in the past—in the van on the great questions of the day (Temperance perhaps excepted), and a terror to evil-doers.

P. S.—Perhaps you can make something out of the foregoing which may be of use to you and your readers. You may think strange perhaps that I do not fully indorse you on the Temperance question. I am a fanatic, they say. I believe the selling and drinking of intoxicating drinks the greatest evil of our day; and when I found Horace Greeley's name on a ticket with B. Gratz Brown, and on a platform which held out no hope in the future on this subject, as much as I loved him and as hard and constantly as I had worked for him in defending him from the lies of his enemies, still I could not vote for him. And as the Christians, Good Templars, and Temperance men generally of our State chose to vote for Gen. Grant and refused to accede to my importunities to get up an electoral ticket for the Prohibition candidates, I could not vote. If THE TRIBUNE was out flat-footed for Prohibition, in my opinion it would be vastly ahead of all other publications I know of. Ahead, however, it is. Still that one thing thou lackest. Go on brethren: you have my good will and I hope you will deserve, as you will get, my money yearly for THE TRIBUNE during the few years that may yet be allotted me.

Trempeleau, Wis., Dec. 1, 1873. E. W.

THE LOSSES BY FIRE IN THE UNITED STATES DURING 1873.

Omitting the 17 large fires reported in other countries during the year 1873, whose losses amounted to $20,815,000, and also the 20 large fires in this country, of which the losses have not been published, a carefully prepared list in *The Boston Journal* shows that 130 fires, each of which destroyed over $100,000 in property, occurred in the United States and Canada, the aggregate losses being $28,011,000. There were 152 fires that destroyed less than $100,000 and over $50,000 each, the property consumed amounting to $9,539,000. Of fires destroying less than $50,000 and over $20,000 there were 306, the losses being $8,560,000. In addition to these, 517 fires occurred in the six New-England States, in which the losses were less than $20,000 and not under $1,000, whose aggregate reaches $3,855,500. Fires destroying less than $1,000 are not noted. The total number of fires reported above is 1,105, and the aggregate losses $49,965,500. The population of New-England as compared to the rest of the country is as 1 to 11½, and if it is supposed that the small fires of the fourth class were as numerous in every other State and Territory as in New-England, the same ratio of loss would give the sum of $44,388,250. This sum added to the total given above would give $94,303,750 as the total losses by fire during 1873 in the United States and Canada.

GENERAL NOTES.

The Maryland House of Reformation has been designated as a place where all colored juvenile offenders against the United States Government are to be confined.

Two Pittsburgh, Penn., surveyors have found a tract of land in that city on which depots, founderies, &c., are built, and which is valued at $14,000,000, and have laid claim to it. The case is in Court, and has not yet been decided.

The anniversary of the birthday of Robert Burns, which occurs on Jan. 25, will be celebrated by the Burns Club by a dinner and ball on Saturday evening, Jan. 24; and by the Caledonian Club with a similar entertainment on the evening of Jan. 26.

There is no animal worse treated than the rat, and no animal oftener has his little revenges. For instance, a rodent gnawed recently a hole in a Dubuque elevator, and before the mischief was discovered 600 bushels of wheat streamed into the dock.

The contest for the checker championship of the world took place in Boston recently between James Wylie, the English champion, and William Barker of that city. Wylie won 9 out of the 42 games played, 32 being drawn, and one resulting in favor of Barker.

It is a novel sort of donation to make to the community, but Gov. Coburn has given to the people of Skowhegan, Me., a beautiful new court-house with a Mansard roof, and cells for prisoners in the basement. The building cost $50,000; the lot was given by the town.

A singular horse accident occurred at Attleboro', Mass., recently. Two fast horses attached to sleighs met each other, head to head. Both fell stunned, and one of them, valued at $1,000, was so paralyzed in the hindquarters that it was necessary to kill him.

The State of Michigan has inaugurated prison reform with gusto. In the State's institutions the convicts cross-striped garments are to be abolished; prisoners will be educated, and when finally discharged each man will receive a suit of clothes, $10 in cash, and such money as he may have earned by overwork.

A Syracuse Justice of the Peace proposes to collect all the coffee grounds from the hotels and restaurants of that city, and treat those of his prisoners who are threatened with the delirium tremens to a cup of beverage therefrom in the morning, so that they may have their wits about them during trial before him.

Rumble-de-bum is a fairy name given to an inmate of the Peoria, Ill., poorhouse; a dirty, half-witted German who used to cut up queer capers and perform military evolutions to the rumble-de-bum of his own voice, and who is the happy possessor of $2,000 in gold, which is waiting his return to the "Fatherland."

The following is a list of Christmas presents given to the "culinary boy" of the Apache House, Cimarron, New-Mexico: A large box filled with tin cups, thread, thimbles, candy, a bottle of worm specific, and a lot of cathartic pills. At last accounts the boy had just finished the candy, and had commenced with the pills.

Here is a pomological mystery. John Schmidtz of Kilbourn City, Ill., has presented to the editor of *The Mirror* of that place an apple, in the center of which was found a piece of sand-stone about the size of a common almond. The apple was sound and perfect. This is more wonderful than reels in bottles or George III.'s apple dumplings.

The inspectors of the Maine State Prison have completed their annual examination of the affairs of the institution, also taking account of stock, and find a handsome balance in favor of the State. The sales were larger than any previous year and the profits satisfactory. The number of prisoners is 129, the smallest for a number of years.

It is hardly worth mentioning. It seems too insignificant for notice. F. S. Bacon, late cashier of the Holyoke National Bank, is a defaulter to the amount of $4,569 83. The report says: "Mr. Bacon's sanity has been almost doubted by his friends." There is no room for doubt, we should say. A sane thief would have taken a great deal more. The "eighty-three cents" settles this matter in our mind.

The Detroit Free Press publishes a list of casualties on the Great Lakes dating from the opening of navigation in April to Dec. 8, 1873. The total number of accidents is 1,021; of these 250 were collisions, 245 vessels went ashore, 9 suffered from explosions, 50 capsized, and 21 were burned. Seventy-eight vessels were total losses, 21 of which were "old hulks" or "rat-traps," which are better out of existence.

It is anticipated, at some future time, that the little town of Cornish, N. H., will be covered by a perfect canopy of national flags. As it is, the people have begun to decorate the tree tops with the American colors already, as the fast accumulating interest on a legacy, left to decorate the place with bunting, will not allow of the erection of flag-poles quickly enough.

Osborn County, Mo., is alarmed and agitated by the presence of a mysterious, wild, ferocious animal with a passion for pigs and chickens. Some say that he is a California lion; some declare him a lynx; others a catamount; others still do scornfully set him down as a tom-cat three sizes larger than common; but he bears away the pigs and chickens all the same, and never stops to be scientifically classified.

A dog who charged with the Federal troops on Gen. Wright's brigade of Georgians at the battle of Spottsylvania Court-house, and was the only "Yankee" who went over the breast-work, has recently died at Columbus, Ga., where she was taken after the war by her captors. She leaves one relative who is cherished, and petted, and looked upon with great respect by all of the children because of his "blood relation."

The Danville (Ill.) *Times* mingles art and business in a clever and taking way in its Carriers' Address. There are some good New-Year's reflections in pleasant verse, to begin with; then the necrology of the year, headed by a touching tribute to Horace Greeley; and a local dialect poem, which gives a first-rate notice to most of the leading tradesmen of the place. Such a practical muse must enrich the newsboys in spite of the panic.

The London Telegraph tells a horrible story of an insane sea captain who, on a voyage across the Atlantic, secretly poured paraffine oil over the deck of his vessel and on a few sails and set them on fire. The crew in attempting to take the captain from the deck of the burning vessel were fired upon, but after a severe struggle succeeded in getting him in the life-boat. Soon after the crew left the vessel she was blown up, and the captain jumped overboard and was drowned during the next night.

Men sometimes express themselves in a roundabout way which is a positive inspiration. A real estate agent in St. Louis recently sent a circular note to the County Clerks throughout the State, asking for certain information, and from one of them he received this answer: "SIR: It took some little time to decipher your chirography, but after I found out what you were after, I knew what you were after, and I think your intention good. Inasmuch as Hell is reported to be paved with good intentions, I recommend that you go there for further information. Yours, &c."

Another sweet little liquor law botheration in Massachusetts! In New-Bedford Michael Kennedy, the janitor of the Mechanics' Club, was complained of for illegally selling liquor. The defense claimed that the liquor was kept only for the members of the Club, but the Court ruled that furnishing liquor to a new member was contrary to law, because the new member was in no way an owner in the liquor on hand at the time of his admission. These legal points are getting sharper and sharper—the old system of special pleading was clumsy in comparison.

By means of the telegraph the Capitol at Washington is placed in direct communication with the National Observatory, and for two minutes before 12 noon, the tick, tick, tick of the clock of the Observatory is reproduced on the magnet at the Capitol with the utmost precision and regularity. As the astronomer notes the time of exact meridian, and touches the key to drop the ball at the Observatory, the same touch conveys an extra tip to the instrument at the Capitol, affording an opportunity to correct the time-pieces at the latter place.

The woman's branch of the Philadelphia P. S. F. T. P. O. C. T. A., who have charge of the "Dog Shelter" in that city, report the following as the operations of the past year: Number of dogs at pound on the 1st of January, 37; dogs received during the year, 3,065; sent by private parties, 112; total, 3,192. The number of dogs redeemed, for which $2 each were received and paid to the city, was 744; number of dogs smothered, 2,378; escaped, 22; died, 38; on hand at the close of the year, 10. The amount paid to the city by the society was $1,488.

The new army boot, introduced into the English service by Sir William Palliser, a distinguished English soldier, gives general satisfaction after undergoing a severe trial by several regiments, both at home and abroad. One feature of the boot consists in placing two thin slabs of cork, reaching from toe to heel, underneath the inner sole of the boot, which renders the sole quite impervious to wet. The object of employing two slabs is in order that the cork in one slab may cover any flaw which may exist in the other.

A lucky fellow in Chicago, who was City Treasurer some five years ago, has been drawing the interest of $200,000 since that time. The money was deposited with him to bind a bargain between a railroad company and the corporation. The city authorities decided to sell a certain property to the railroad company for $700,000. A number of property holders obtained an injunction restricting the city from disposing of the land, and the railroad people refused to receive their advanced $200,000. The new City Treasurer declined to take the money, because the city has no claim in the matter, and so this much abused man has to take care of that large sum and pocket the interest.

The following is the latest case of "salary grabbing" as chronicled by a Hartford paper: "In New-Haven the bookkeeper of a manufacturing concern was gratified a year ago by having his salary raised from $1,000 to $1,200. On the last day of 1873 he was notified that his salary was reduced to $1,000, and dated back a year, bringing him in debt to the company $200, with the additional information, to make him happy, that for the coming year he need expect but $800! He now thoroughly understands the mysteries of the 'back salary grab.'" But Hartford and New-Haven are not on the best of terms, and there is some little room for exaggeration.